

Behaviour of Radiations at $\lambda\lambda 4634-41$ and at $\lambda 4650$ in the Wolf-Rayet Stars. By C. D. Perrine.

Dr. Lunt in his paper, *Monthly Notices, R.A.S.*, March 1920, p. 534, comments upon the fact that in Campbell's results for the Wolf-Rayet stars the bands 4634 and 4650 never appear together in the same star. This fact (as well as the duplicity of the higher radiation) was noticed by me about two years ago, and has been under investigation at intervals since. The complementary behaviour of these relations is so marked and seems so significant that a preliminary note was prepared a year ago, but as further points of interest were encountered, its publication has been delayed.

Not only do these two series of radiations appear not to be present together in the same star, but it has been found that 4634 and 4641 are present only when the lines are rather narrow. When the bands are very broad these two lines cannot be detected. Under these conditions only the radiation at 4650 (or 4649) appears to be present. Out of 22 stars, 12 with bands at 4650 showed none at 4634-41, and 10 with bands at 4634-41 showed none (with one possible exception) at 4650. The possible exception is the star A.G.C. 23073, which shows what may prove to be traces of structure at 4650. It is very faint, and consists of an absorption line with brightened edges. This detail appears to be of the same general character as that observed in some early B type stars, and is now under investigation. As all of these radiations have been identified together in the Novæ, it cannot be reasonably urged that they cannot exist together in the Wolf-Rayet stars, although but one case has been observed which can be considered as possibly contradictory.

The behaviour is so well marked, however, that it can be said that when the lines and bands are narrow 4634-41 are present, and practically no traces of emission at 4650 present; whereas when the bands are very wide 4650 is very pronounced and 4634-41 are either not present at all or cannot be detected. The star A.G.C. 23073 is probably very near the transition stage.

These characteristics may be further generalised by saying that 4650 appears to be very sensitive—the most sensitive so far detected in the ordinary photographic region, and that it is only present as strong emission where the great widths of the bands justify the belief that the star's surface is very active, due probably to high temperature. The presence in the Novæ of 4650 along with 4634 and 4641 indicates different behaviour or characteristics of these elements in the Novæ, perhaps depending upon the suddenness or violence of the outburst. The more leisurely march of the Wolf-Rayet stars probably gives time for the separate appearance of phenomena which in the Novæ are jumbled together in a small interval of time.

Wright has suggested the 4686 line as a means of classifying

the nebulae.* The emission at 4650 appears to be more sensitive than that at 4686, and I would suggest its inclusion together with 4634-41 in any scheme for the classification of both the Wolf-Rayet stars and nebulae. A study of the lower regions of the spectrum may lead to other radiations which should be included also in their classification.

Observatorio Nacional Argentino, Cordoba:
1920 October 23.

Presence of Emission at $\lambda\lambda$ 4634 and 4641 in the Spectra of the Wolf-Rayet Stars. By C. D. Perrine.

Dr. Lunt, in his article on the spectrum of Nova Aquilæ No. 3 in the *Monthly Notices* for March, discusses the relation of spectra of novæ to those of the Wolf-Rayet or Class O stars. He calls attention to the presence among others of $\lambda\lambda$ 4604, 4634, 4650, and 4686 in both, and concludes that the radiation at 4641 is peculiar to the novæ. This confusion as to the presence of 4641 is doubtless due chiefly to the fact that the early observers of these stars failed to separate the two lines 4634-41. An explanation for the position 4634 for the blend is not evident.

In a footnote to his article on the enhanced lines of nitrogen in *Monthly Notices* for June, Professor Fowler refers to the observation of the two lines 4634 and 4641 in the spectrum of the Wolf-Rayet star A.G.C. 22748 by Paddock,† and in several nebulae by Wright.‡ The object of the present note is to strengthen this datum by the inclusion of other Wolf-Rayet stars in which both lines have been observed.

Spectrograms taken with the astrographic refractor and a 20° prism of 5 inches aperture placed in front, dispersion 33Å per millimetre at H_γ , show that in the six stars A.G.C. 22748, 22763, 22843, 23073, C.P.D. -59° 2450 and C.P.D. -59° 2548, both radiations are present. In A.G.C. 22748 and 22843 these lines are narrow, of nearly equal intensity, and well separated. In A.G.C. 23073 the lines are less sharp, but both radiations are distinguishable. In 22763 the lines are considerably widened, yet 4634-41 is certainly double. In C.P.D. -59° 2450 and -59° 2548 the radiations are much widened, yet both 4634 and 4641 are clearly discernible. A.G.C. 22827, C.P.D. -58° 2546 and γ Argûs have the bands so widened, and the spectra of the first two are so much fainter, that they furnish no evidence on the radiations in question. These are (with ζ Puppis, to be

* *Proceedings National Academy of Sciences*, 1, 590, 1915.

† *Lick Observatory Bulletin*, 8, 78, 1914.

‡ *Publications Lick Observatory*, 13, 193, 1918.